

Breathing Rhythms Coordinate Brain Waves to Strengthen Memory During Sleep

Analysis by [Dr. Joseph Mercola](#)

January 17, 2025

STORY AT-A-GLANCE

- › Sleep plays a key role in memory consolidation through neural mechanisms that replay and strengthen recently acquired information, a process that integrates new knowledge with existing memories
- › Northwestern University researchers found that breathing patterns during sleep coordinate hippocampal brain waves, marking the first direct link between breathing rhythms and memory-related brain activities
- › Research also showed that during slow-wave sleep (SWS), neurons cycle between periods of increased activity and rest, synchronizing neural networks and strengthening memory pathways; disrupted sleep undermines this balance
- › Sleep apnea significantly disrupts memory formation, with affected individuals being 50% more likely to report cognitive problems compared to those without symptoms, according to 2024 research
- › Treatment options for sleep apnea focus on addressing root causes through oral appliances, myofunctional therapy and the Buteyko Breathing Method, rather than relying on symptom management alone

The relationship between sleep and memory has been recognized for centuries. A recent study¹ from Northwestern University highlights the observation made by the Roman scholar Quintilian, who stated, “the interval of a single night will greatly increase the

strength of the memory.”² Modern neuroscience has since demonstrated that this effect is due to the brain's ability to replay and consolidate memories during sleep.

This process not only strengthens recently acquired information but also integrates it with existing knowledge, making sleep an essential component of learning and cognitive performance. It involves precise neural mechanisms, including the reactivation of memory-related brain circuits and the synchronization of brain waves, which facilitate the encoding and long-term storage of memories.

The Northwestern University study³ has further advanced this understanding by identifying a connection between breathing rhythms and memory consolidation during sleep. It's the first study to directly link these rhythms to memory-related brain activities, which have important implications for conditions like sleep apnea, where disordered breathing interferes with the brain's ability to consolidate memories.

Breathing Synchronizes Sleep Oscillations in the Hippocampus

Published in the Proceedings of the National Academy of Sciences,⁴ the featured study hypothesizes that breathing directly influences the coordination of sleep-related brain rhythms. The authors explained:

“Brain rhythms during sleep coordinate activity across different neural systems, as part of memory consolidation processes. These coordinated sleep oscillations occur throughout non-REM [rapid eye movement] sleep in bursts, and have widely been assumed to emerge intrinsically during sleep with no underlying rhythm or external impetus.”⁵

The researchers observed that these sleep oscillations follow a slow rhythm every three to six seconds, a frequency that matches natural breathing rates during sleep. Their findings show that breathing generates a slow rhythm in the hippocampus, the brain region responsible for encoding and consolidating memories. This rhythm synchronizes with hippocampal sleep oscillations, ensuring precise coordination of memory-related processes.

In addition, the researchers found that breathing facilitates the nesting of sharp wave ripples, which are brief, high-frequency bursts of activity that occur in the hippocampus. This nesting is an essential component of memory consolidation, as it allows the hippocampus to communicate efficiently with the cortex, strengthening and storing memories.

These findings suggest that breathing is not merely a passive physiological process during sleep but actively contributes to the synchronization of brain activity involved in memory processing, emphasizing the importance of stable respiratory patterns during sleep for cognitive health.

“People with disrupted breathing during sleep should seek treatment for it,” said Andrew Sheriff, one of the study’s authors. “When you don't get sleep your brain suffers, your cognition suffers, you get foggy. We also know that sleep-disordered breathing is connected with stroke, dementia and neurodegenerative disorders like Alzheimer's disease.”⁶

These findings align with earlier research in the *Journal of Neurophysiology*,⁷ which demonstrated that respiratory-driven synchronization occurs during both sleep and wakefulness. In wakeful states, it enhances focus, attention and problem-solving, while during slow-wave sleep (SWS), it optimizes the transfer of information from the hippocampus to the cortex.

The Importance of Deep Sleep in Memory Formation

Deep sleep, specifically non-REM sleep, plays a vital role in memory formation by strengthening connections between neurons (synaptic consolidation). A key mechanism involves the oscillations between periods of heightened neural activity (UP states) and rest (DOWN states).

A recent study published in *Nature Communications*⁸ investigated the role of these brain states in synaptic consolidation, the process that reinforces connections between

neurons. Using brain tissue from patients undergoing neurosurgery, the researchers examined how these oscillating states influence neural communication in the neocortex.

During SWS, neurons alternate between UP states of increased activity and DOWN states of rest, which temporarily quiet the system. This cycling creates opportunities for neurons to reset and synchronize, enhancing the flow of information. The researchers found that UP states enhanced the strength of connections between neurons by broadening electrical signals in the brain.

This effect was particularly strong when UP and DOWN states occurred in a sequence, creating ideal conditions for neurons to synchronize and exchange information. If this synchronization failed, neural connections weakened, highlighting the importance of well-timed activity during sleep.

Their findings also revealed that UP and DOWN states refine communication between neurons by stabilizing strong connections while weakening less important ones. This selective process optimizes brain capacity, preserving essential information while discarding irrelevant ones. Disrupted sleep undermines this balance, impairing your brain's ability to organize and retain memories.

How Sleep Apnea Affects Cognition and Overall Health

Sleep apnea is a prevalent sleep disorder characterized by repeated interruptions in breathing during sleep. Studies have shown that it significantly disrupts the synchronization of brain activity necessary for memory consolidation, affecting both your short-term and long-term memory.⁹

For instance, an April 2024 study published in the journal *Neurology*¹⁰ looked at data from a nationwide survey of U.S. adults and found a strong connection between sleep apnea symptoms and memory problems. People who experienced signs of sleep apnea, such as gasping, snorting or pauses in breathing during sleep, were much more likely to report memory lapses, confusion, difficulty concentrating and poor decision-making.

Even after adjusting for factors that affect memory and thinking, such as age, race, gender and education, researchers found that individuals with sleep apnea symptoms were 50% more likely to report memory or thinking problems compared to those without symptoms.¹¹

In children, the effects of sleep apnea are also significant. Research published in the *Journal of Clinical Sleep Medicine*¹² found that children with REM sleep-related obstructive sleep apnea (REM-OSA) had greater difficulty consolidating declarative memories compared to children with non-REM OSA (NREM-OSA) or no sleep issues. This study involved children aged 6 to 14 who underwent sleep studies and memory testing.

Children with REM-OSA performed worse in memory recall tasks than healthy children and those with other types of sleep-disordered breathing. The severity of breathing interruptions during REM sleep was also linked to lower recognition memory scores, emphasizing the importance of uninterrupted REM sleep for memory formation. This suggests that memory deficits in REM-OSA are directly linked to disrupted REM sleep processes rather than frequent awakenings.

Aside from causing harmful cognitive changes, breathing disruptions also promote poor health and increase your risk of chronic disease by:

- Reducing the amount of oxygen in your blood, which impair the function of internal organs and exacerbate other health conditions you have
- Slowing down or preventing the detoxification of your brain tissue, as your brain's waste removal system, known as the glymphatic system, only operates during deep sleep
- Disrupting your circadian rhythm, resulting in reduced melatonin production and disruption of other body chemicals
- Inhibiting the release of growth hormone, preventing optimal growth and development

- Increasing sympathetic tone, causing problems with bedwetting, night sweating, night terrors, restless sleep and anxiety

Address the Root Cause of Sleep Apnea for Better Health

If you or someone in your family has sleep apnea, identifying and addressing the root cause is key to achieving lasting relief and better overall health. Start by consulting a qualified sleep specialist. Be prepared to seek out professionals who focus on addressing the underlying issues, as many rely primarily on CPAP machines for symptom management.

While CPAP machines offer symptom relief, they fail to tackle the root cause and often come with challenges such as discomfort, maintenance requirements and the risk of disrupted sleep due to noise and electromagnetic fields. Additionally, CPAP is not ideal for long-term use, particularly in children, as it alters facial structure over time.

In some cases, enlarged tonsils or adenoids are contributing factors, and their removal might be recommended. However, if breathing patterns, chewing and swallowing habits are not corrected, structural issues in the airway will reoccur. If obesity is a factor, weight loss significantly alleviates sleep apnea.

For cases related to tongue or jaw positioning, a dentist trained in sleep apnea treatment will design custom oral appliances to expand the palate and move the jaw or face forward, addressing the issue at its source. Combining these devices with myofunctional therapy, which strengthens the muscles involved in breathing and swallowing, enhances effectiveness.

For adults, oral appliances such as mandibular repositioning devices shift the jaw forward, while others hold the tongue in place without altering jaw position. These devices have been part of the standard of care for sleep apnea since 1995 and are often recommended as a first-line treatment for mild to moderate cases. Including myofunctional therapy in the treatment plan also reduces the risk of jaw discomfort or temporomandibular joint (TMJ) problems.

To explore oral appliance therapy, the American Academy of Dental Sleep Medicine¹³ is a reliable resource for finding specialists. Additionally, an oral myofunctional therapist provides valuable support in correcting breathing patterns and oral function. Locate qualified therapists through the Academy of Orofacial Myofunctional Therapy.¹⁴

Proper nasal breathing is essential for long-term improvement. Explore techniques like the Buteyko Breathing Method to retrain breathing habits and optimize airway function. With a comprehensive approach, you'll be able to address sleep apnea effectively, leading to better sleep and overall health.

Optimize Your Breathing with the Buteyko Method

The Buteyko Breathing Method, named after the Russian physician who pioneered the technique, is a highly effective approach to reducing sleep apnea. By training yourself to consistently breathe through your nose instead of your mouth, you normalize your breathing volume, enabling optimal oxygenation of tissues and organs, including your brain.

Your diet plays a significant role in shaping your breathing patterns. Processed foods acidify the blood, forcing your body to overcompensate to maintain normal pH levels. This leads to heavier breathing and chronic overbreathing, as carbon dioxide, an important regulator of blood pH, is expelled too quickly. Eating a diet rich in antioxidants and engaging in regular physical activity enhance your body's ability to produce and utilize CO₂ more efficiently.

Signs of overbreathing include mouth breathing, shallow chest breathing, frequent sighing, audible breaths at rest and large inhales before speaking. Recognizing these patterns is important, as improper breathing during the day increases your risk of sleep-related breathing issues. The Buteyko Breathing Method offers a proven solution to restore healthy breathing habits and improve your overall respiratory function.

Sources and References

- ^{1, 3, 4, 5} Proc. Natl. Acad. Sci. U.S.A. 121 (52) e2405395121
- ^{2, 6} News Medical, December 16, 2024
- ⁷ J Neurophysiol. 2019 Jun 19;122(2):563–571
- ⁸ Nature Communications Volume 15, Article Number: 10340 (2024)
- ⁹ NCBI, How Sleep Apnea Affects Memory Formation
- ¹⁰ Neurology. April 2024, Volume 102: Number 17 (Supplement 1)
- ¹¹ Science Daily, March 4, 2024
- ¹² J Clin Sleep Med. 2024;20(3):417–425
- ¹³ American Academy of Dental Sleep Medicine
- ¹⁴ Academy of Orofacial Myofunctional Therapy